

Two New Nematodes from the Families Molineidae and Strongyloididae (Nemata): Parasites of *Caenolestes* (Mammalia: Paucituberculata: Caenolestidae) from the Andes of Ecuador

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Abstract

A new genus and species of Molineinae (Nemata: Trichostrongyloidea) is described. It is similar to *Molineus* but differs in ray 4 being longest instead of shortest. In addition, a new species of *Parastrongyloides* is described that is characterized by a short digitiform appendix on the tail and spicule tips with fine points. It is the second species known with two morphotypes of the females.

Resumen

Se describe un nuevo género y especie de Molineinae (Nemata: Trichostrongyloidea), similar a *Molineus* pero difiere en que en la bolsa caudal el rayo 4 es el más largo en lugar de ser el más corto. Además, se describe una nueva especie de *Parastrongyloides* que se caracteriza por un apéndice digital corto y las espículas terminan con puntas finas. Es la segunda especie conocida con dos morfotipos de hembras.

Keywords: Neomolineus, Parastrongyloides, Molineidae, Strongyloididae, Nematoda, Caenolestes, Paucituberculata, Ecuador

Introduction

The Caenolestidae is a small group of insectivorous marsupials of the suborder Paucituberculata that is thought to have originated in the late Oligocene (Reig, 1981; McKenna and Bell, 1997). Extant forms are endemic to South America and live in mountains from the border between Colombia and Venezuela south into the Andes of south-central Chile (Patterson, 2007). The genus *Caenolestes* Thomas, 1895 contains five species, all with distributions

that include the Andes of Ecuador (Timm and Patterson, 2007; Ojala-Barbour et al., 2013). Currently, fleas, lice, chiggers, ticks, and other acarid ectoparasites have been reported (Guerrero, 1985; Fain and Bochkov, 2003; Timm and Patterson, 2007; Bochkov and O'Connor, 2008, 2009; Bochkov et al., 2013), but few endoparasites have been reported or described (Guerrero, 2016; Spratt, 2017). Reviewing material maintained in ethanol after collection several years ago, two new species of nematodes were found and are described here.

Material and Methods

Mammals preserved in 70% ethanol in the Sección de Mastozoología del Departamento de Ciencias Biológicas, Escuela Politécnica Nacional and Division de Mastozoología, Instituto Nacional de Biodiversidad, were dissected and the body cavities and entire digestive tracts examined for helminth parasites. Nematodes were cleared with Amman's lactophenol, placed on a microscope slide under a cover slip, and examined using a Nikon Labophot YF-21E with Camera DS-Fi1 and Control Unit DS-L2 with measurement software. Measurements were confirmed using an ocular micrometer; drawings were made using a camera lucida. All measurements are given in micrometers (μm) for the holotype (or allotype), followed by the mean (minimum–maximum \pm standard deviation). The synlophe and caudal bursa of the trichostrongylids were studied according to methods and nomenclature developed by Durette-Desset et al. (2017). Description of *Parastrongyloides* follows Guerrero (2016). Type specimens have been deposited in Instituto de Ciencias Biológicas de la Escuela Politécnica Nacional de Quito, Ecuador (MEPN), Instituto Nacional de Biodiversidad Quito, Ecuador (AC-INABIO), and Colección de Parasitología, Museo de Biología, Universidad Central de Venezuela (CP-MBUCV), Caracas, Venezuela. All measurements are in micrometers unless otherwise indicated.

DESCRIPTIONS

Phylum Nemata

Class Secernentea von Linstow, 1905

Order Strongylida

Superfamily Trichostrongyloidea

Family Molineidae

Subfamily Moleninae

Neomolineus n. gen.

LSIDurn:lsid:zoobank.org:act:35EAC282-DBD3-42D0-826B-3815C37F1EE8

Description/Diagnosis

Small, thin nematodes, body not coiled. Cephalic vesicle well developed and longer than wide with delicate annulations. Female, didelphic/amphidelphic. Synlophe, as in *Molineus*, with tips of cuticular ridges oriented perpendicular to body wall. Males with short spicules divided distally into three branches. Bursa type 2-3 with dorsal ray terminating in 2 sets of 3 branches each. Caudal bursa with rays 2 to 6 arranged parallel, ray 4 longer than rays 3 and 5; all species in *Molineus* are characterized by ray 4 being shorter than the other rays of the lateral lobes. In *Neomolineus*

ray 4 is longer than the other rays of the lateral lobes and very narrow.

Neomolineus pierredesseti n. gen. n. sp. (Figures 1–11)

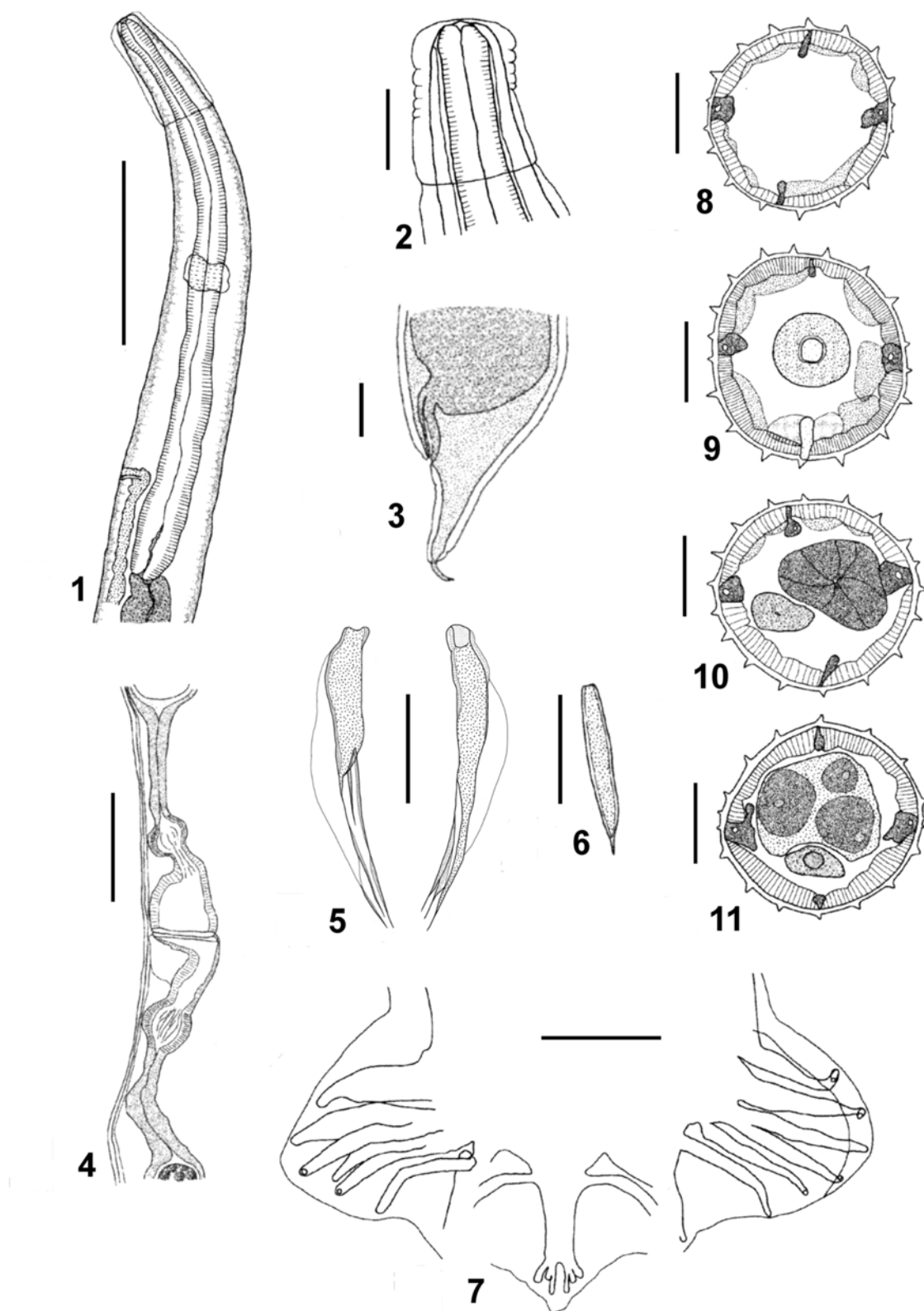
Description: *General:* Small, thin nematodes. Body not coiled. Cephalic vesicle well developed, longer than wide with delicate annulations. Cephalic vesicle appearing longer in males. Caudal bursa subsymmetrical, pattern 2-3. Vulva in posterior third.

Synlophe: With eighteen ridges continuous throughout body, oriented perpendicular to body surface. Ridges commence posterior to cephalic vesicle, terminate just anterior to caudal bursa in males, at caudal extremity in females, seven dorsal, seven ventral, two slightly smaller opposite each lateral field, all regularly spaced. Size of pairs on lateral fields decreasing posteriad, becoming minute near posterior end.

Males (4 specimens): Body 3,331, 2,823 (2,494–3,331 \pm 364) long; 89, 67 (59–89 \pm 14.7) maximum width. Cephalic vesicle 71, 74 (66–87 \pm 9.1) long, 36, 30 (26–36 \pm 4.6) wide. Nerve ring and excretory pore at 184, 179 (169–190 \pm 9.7) and 232, 281 (232–308 \pm 33.8) from apex, respectively. Esophagus 384, 373 (358–384 \pm 10.9) long, representing 11.5, 13.3 (11.5–13.3 \pm 1.4) of body length. Spicules 76, 72 (67–76 \pm 4.2) long, representing 2.3, 2.6 (2.3–2.8 \pm 0.2) % of body length; tips of spicules with three branches. Caudal bursa subsymmetrical, pattern 2-3. Rays 2-3 arising first and together from trunk of rays 2 to 6; rays 4, 5, and 6 parallel, diverging at distal extremities; ray 5 shorter than 4 and 6, ray 4 longest. Dorsal trunk divided in two branches at distal extremity, each originating three small branches; the externals are rays 9, phasmids (rounded), and rays 10 (the internals). Gubernaculum simple, rectangular, ending posteriorly in point, and 24, 30 (24–36 \pm 5.0) long.

Female Allotype: Body 5,701 long; 148 in maximum width. Cephalic vesicle 63 long, 43 wide. Nerve ring, deirids, and excretory pore at 243, 291, and 273 from apex, respectively. Esophagus 469 long, representing 8.3% of body length. Tail 78 long, representing 1.37% of body length; 38 wide; caudal spine 19 long. Ovejector straight with branches of vestibule equal. Vulva at 1,529 from caudal extremity. Vagina vera 51 long. Vestibules, anterior 88, posterior 79 long. Sphincters, anterior 33, posterior 47 long. Infundibula, anterior 119 long, posterior 125 long. Uterine branches, anterior 733 with 6 eggs, posterior 638 with 4 eggs. Eggs 96 long, 50 wide.

Type material: Holotype σ (AC-INB-0005), Allotype f (AC-INB-0006), 3 $\sigma\sigma$ paratypes (MEPN 18195). LSIDurn:lsid:zoobank.org:act:02E2BF96-35E0-4B5A-AA18-69CE8E8FB12C



Figures 1–11. *Neomolineus pierredesetti* n. gen. n. sp. Female: **1.** Anterior extremity, lateral view. **2.** Cephalic vesicle. **3.** Tail, lateral view. **4.** Vulvar region, lateral view. Male: **5.** Spicules, ventral view. **6.** Gubernaculum, ventral view. **7.** Caudal bursa, ventral view. **8.** Synlophe at esophagus. **9.** Synlophe at excretory pore. **10.** Synlophe at midbody. **11.** Synlophe anterior to spicules. (Figures 1, 4 bar = 100 μ m; 2, 3, 5, 6, 7, 8, 9, 10, 11 bar = 25 μ m)

Type-host: *Caenolestes convelatus* Anthony, 1924 (Mammalia, Paucituberculata, Caenolestidae), INB 796.

Other host: *Caenolestes condorensis* Albuja & Patterson, 1996 (Mammalia, Paucituberculata, Caenolestidae), MEPN 7462.

Type-locality: Cotacachi Capayas Ecological Reserve, Imbabura, Ecuador (0°29'14"N, 78°29'33"W), 2,600 m.

Other locality: Provincia Morona Santiago, cantón Gualaquiza, parroquia Bomboiza, sector Achupallas, Reserva Ecológica El Quimi, Ecuador (3°27'03"S, 78°21'39"W), 2,080 m.

Site: Small intestine.

Etymology: The species is named after Pierre, husband and right hand of Marie-Claude Durette-Desset, a good friend now recently passed away.

Prevalence: 50%, 1 host infected of 2 *C. convelatus*. 100%, 1 of 1 *C. condorensis*.

Intensity: 1 male, 1 female in *C. convelatus*; 3 males in *C. condorensis*.

Differential diagnosis: All specimens have similar morphology: Synlophe with ridges oriented perpendicular to body surface, cephalic vesicle simple, female didelphic/amphidelphic, vulva in posterior third, short tail terminal spine, males with short spicules divided distally into three branches, bursa type 2-3 and dorsal trunk ending in 3 branches characteristic of Molineinae. There are 26 genera in the subfamily, 17 parasites of mammals (Beveridge et al. 2014): *Angulocirrus* Biocca & LeRoux, 1957; *Brygoonema* Durette-Desset & Chabaud, 1981; *Dollfusstrongylus* Quentin, 1970; *Hepatojarakus* Yeh, 1955; *Hugotnema* Durette-Desset & Chabaud, 1981; *Lagostonema* Sutton & Durette-Desset, 1987; *Moguranema* Yamaguti, 1941; *Molineus* Cameron, 1923; *Molinostrongylus* Skarbilovitch, 1934; *Mainspinostrongylus* Kalyankar & Palladwar, 1989; *Nochtia* Travassos & Vogelsang, 1929; *Nycteridostongylus* Baylis, 1930; *Ortleppstrongylus* Durette-Desset, 1970; *Pithecostrongylus* Lubimov, 1930; *Shattuckius* Sandground, 1938; *Trichocheenia* Kou, 1958; and *Tupaiostrongylus* Dunn, 1963. Females of *Ortleppstrongylus* are monodelphic; our specimens are didelphic. *Hepatojarakus* and *Moguranema* have a corona radiate; our specimens do not. The spicules of *Angulocirrus* are dissimilar, but in our males they are similar. In females of *Molinostrongylus*, *Nycteridostongylus*, and *Tupaiostrongylus* the ovejector is kidney-shaped; in our specimens it is not. In *Mainspinostrongylus*, *Molineus*, *Trichocheenia*, and *Brygoonema* ray 4 is shorter than rays 3 and 5; in our specimens ray 4 is longer than rays 3 and 5. In *Nochtia* the spicules are more than 300 µm long; in our specimens spicules are less than 100 µm. In the synlophe of *Hugotnema* and *Lagostonema* at least some ridges are not oriented perpendicular to the body; in our specimens all

ridges are perpendicular to the body. Lateral alae are present in *Dollfusstrongylus* and *Phitecostrongylus* but absent in our specimens. Rays 2 to 6 are divergent in *Shattuckius* but parallel in our specimens. In these features, these specimens differ from all other genera of Molineinae.

The synlophe of *N. pierredesseti* is similar to that of *Molineus* Cameron, 1923, but all species in *Molineus* are characterized by ray 4 being shorter than the other rays of the lateral lobes. In *Neomolineus* ray 4 is longer than the other rays of the lateral lobes and very narrow.

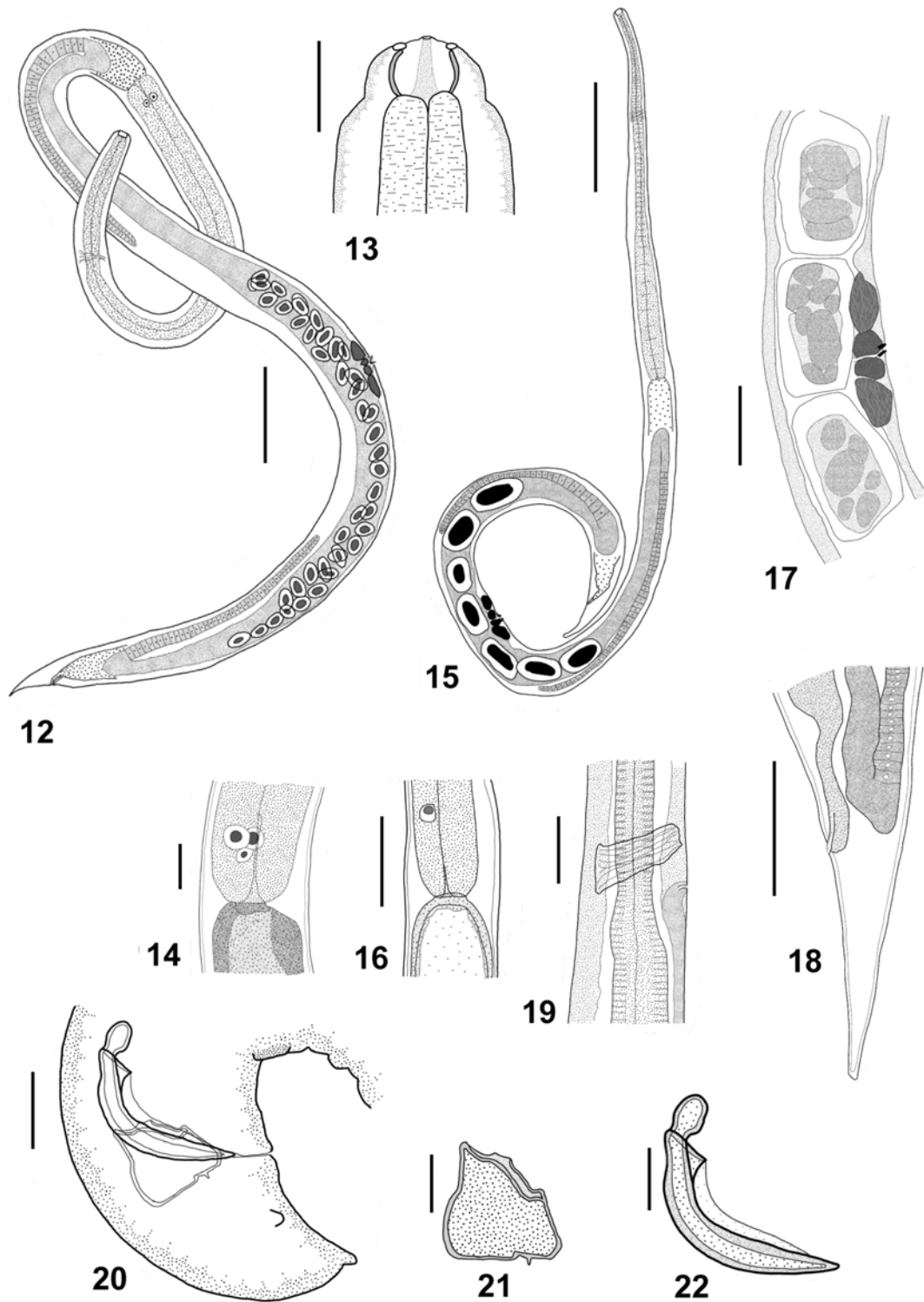
Caenolestes is probably a capture host like *Lachesis* sp. which harbors *Molineus inexpectatus* (Durette-Desset et al., 2000).

***Parastrongyloides scottgardneri* n. sp.** (Figures 12–22)

Description: *General:* Small, delicate nematodes. In apical view with well-developed amphids and four cephalic papillae. Rectangular buccal capsule, wider than long, with poorly cuticularized thick walls, concave in shape. Esophagus divided, anterior shorter, thinner, muscular; posterior longer, slightly wider, glandular. Nerve ring and excretory pore in anterior part of esophagus. Conical tail in both sexes.

Males (14 specimens): Body 895, 903 (748–1,097 ± 90.3) long and 35, 33.8 (21–47 ± 7.3) maximum width; width at the esophageal-intestinal junction 25, 28.2 (23–34 ± 3.6). Buccal capsule 3.7, 3.9 (3.6–4.7 ± 0.3) wide and 3.3, 3.1 (2.4–3.7 ± 0.3) long. Total length of esophagus 317, 324 (293–368 ± 24.4), corresponding to 35.4, 36 (32.3–41.2 ± 2.5) % of total body length, anterior 125, 98 (93–125 ± 10.5) long, posterior 192, 224 (192–261 ± 24.4) long. Nerve ring 87, 89 (71–134 ± 12) from anterior extremity, excretory pore 95 from same extremity in holotype. Testis long, beginning 45, 52 (9–107 ± 31.5) posteriorly to esophageal-intestinal junction. Tail subconical, ending with digitiform appendix more or less developed, 30, 27.4 (21–31 ± 2.8) long, 25, 26.4 (21–33 ± 3.0) wide; one small, median, unpaired papilla 14, 16.7 (7.3–21.8 ± 5.5) anterior to cloaca, 4.5, 4.7 (2.6–7.3 ± 2.1) in diameter. Spicules equal, sickle-shaped, with knoblike proximal ends, pointed distal ends, and ventral alae, clothed in membrane, 38, 39 (33–48 ± 4.8) long, 5.4, 4.12 (3.3–5.1 ± 0.7) wide, alae 3.1, 3.3 (1.4–4.4 ± 0.8) maximum width. Gubernaculum rhomboid in shape with small spike posteriorly 20, 22 (18–29 ± 3.4) long, 14, 15 (13–20 ± 2.3) wide.

Females: There are two types of females, one type more abundant, smaller with none to 8 eggs, second group rare, larger, with 39–58 eggs. First group (18 specimens): Body 1,077, 1,023 (877–1,130 ± 74) long, 44, 38 (29–44 ± 4.4) maximum width, width at esophageal-intestinal junction 29, 27 (21–34 ± 3.3), at vulva 42, 36 (28–44 ± 5.0). Buccal



Figures 12–22. *Parastrongyloides scottgardneri* n. sp. *Females* (big): **12.** Total, lateral view. **13.** Buccal capsule. **14.** Esophageal-intestinal junction. *Female* (small): **15.** Total, total view. **16.** Esophageal-intestinal junction. **17.** Vulvar region, lateral view. **18.** Tail. *Male*: **19.** Nerve ring and excretory pore. **20.** Tail, lateral view. **21.** Gubernaculum, lateral view. **22.** Spicule, lateral view. (Figures 12, 15 bar = 100 µm; 14, 16, 17, 18 bar = 25 µm; 13, 19, 20, 21, 22 bar = 10 µm)

capsule 4.7, 4.3 (3.7–4.9 \pm 0.4) wide, 3.3, 3.1 (2.4–3.6 \pm 0.3) long. Total length of esophagus 343, 324 (293–361 \pm 21.8), and corresponding to 31.8, 31.8 (28.3–39.6 \pm 2.9) % of total body length, anterior 99, 97 (73–119 \pm 11.0) long, posterior 244, 225 (193–255 \pm 20.9) long. Nerve ring and excretory pore 92, 89 (73–108 \pm 10) and 98, 94 (80–107 \pm 10) from anterior extremity, respectively. Vulva 362, 342 (266–395 \pm 36) from caudal extremity, relationship total length/distance vulva-caudal tip 2.98, 3.16 (2.91–3.41 \pm .35), lips and vagina inconspicuous, advulvar muscles well developed. Uterus, amphidelphic, the anterior ovary directed anteriorly and after junction with ovary and uterus, uterus then directed posteriorly to vulva 44, 39 (12–68 \pm 39.4) to level of the esophageal-intestinal junction, and the posterior ovary directed posteriorly then bending back to become the posterior uterus connecting to the vulva, 16, 11 (0–22 \pm 7.3) anteriorly to anus. Eggs usually in morula stage in uterus, 6, 3.4 (0–8 \pm 3.4) in number, 38, 41 (36–47 \pm 3.2) long, 22, 23 (18–29 \pm 2.7) wide. Tail conical, 36, 39 (32–44 \pm 4.2) long, 16, 15 (13–17 \pm 1.0) wide.

Second group (2 specimens): Body 1,912, 1,929 long, 60, 81 maximum width, and body width at esophageal-intestinal junction 53, 60, and at vulva 66, 80. Buccal capsule 5.3, 7.0 wide by 3.8, 4.8 long. Total length of esophagus 605, 645, anterior 127, 127 long, posterior 478, 518 long, corresponding to 31.6 and 33.4% of the total body length. Nerve ring 132, 103 from anterior extremity. Vulva 566, 658 from caudal extremity, relationship total length/distance vulva-caudal tip 3.41, 2.91; ovaries, anterior 33, 96 posterior to esophageal-intestinal junction, posterior 66, anterior to anus. Eggs 39, 58 in number, 38, 40 long, 21, 23 wide. Tail conical 34, 38 long, 18, 18 wide.

Type material: Holotype ♂ (AC-INB-0007), Allotype ♀ (AC-INB-0008), Paratypes 14 ♀♀ and 8 ♂♂ (AC-INB-0009); 5 ♂♂ and 5 ♀♀ (CP-MBUCV 6309). **LSID** urn:lsid:zoobank.org:pub:F5AA3B0E-4C6E-4852-B29E-02CFFEF18361D

Type-host: *Caenolestes convelatus* Anthony, 1924 (Mammalia, Paucituberculata, Caenolestidae), ♂, INB 796.

Type-locality: Zona El Marañón área de Amortiguamiento Reserva Ecológica Catacachi Cayapas, Cuellaje, Catacachi, Imbabura, Ecuador (0°30'34"N, 78°32'39"W), 2,620 m.

Site: Small intestine.

Etymology: Named after Scott L. Gardner in honor of his contribution to knowledge of parasites from wild mammals.

Intensity: 47 specimens in 1 individual of *C. convelatus*.

Remarks: The genus *Parastrongyloides* includes 13 species with a cosmopolitan distribution (Guerrero, 2016; Spratt, 2018). These are: *Parastrongyloides winchesi* Morgan, 1928; *P. skrjabini* Petrov & Savinov, 1959; *P. trichosuri*

Mackerras, 1959; *P. perameles* Mackerras, 1959; *P. australis* Mawson, 1960; *P. chrysochloris* Quentin, 1969; *P. callipygus* Hugot, 1979; *P. neotropicalis* Guerrero, 2016; *P. tachyglossi* Spratt, 2017; *P. caenolestis* Spratt, 2017; *P. nadgeensis* Spratt, 2018; *P. timbillicensis* Spratt, 2018; and *P. walterae* Spratt, 2018. The species are very similar morphologically and morphometrically, with the exception of *P. trichosuri*, which is more than two times longer than the others. The main character to distinguish species are shape of male tail, dome-shaped precloacal papillae, spicule tips, and gubernaculum. *Parastrongyloides australis*, *P. skrjabini*, and *P. trichosuri* have a rounded end of the tail without any tip or spine; *P. scottgardneri* n. sp. does not have a rounded end; *P. caenolestis*, *P. callipygus*, *P. neotropicalis*, *P. tachyglossi*, and *P. winchesi* have a conical tail without terminal tip or spine; *P. scottgardneri* has a short digitiform spurlike process as in *P. peramelis*, *P. nadgeensis*, *P. timbillicensis*, *P. walterae*, and *P. chrysochloris*. *P. walterae* does not have a dome-shaped precloacal papilla, but *P. scottgardneri* does. *P. peramelis* and *P. chrysochloris* have a gubernaculum rounded posteriorly and with a very different shape than those of *P. scottgardneri*. *P. nadgeensis* and *P. timbillicensis* have blunt male spicule tips not clothed in membrane; *P. scottgardneri* has sharply pointed tips of the spicules clothed in a thin membrane.

To date, only the type species, *P. winchesi* has been reported with two types of females, one group small with few eggs and the second group larger with large numbers of eggs, while *P. scottgardneri* exhibits the same condition with two sizes of females.

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